OPX - A High Performance libfabric Provider for Omni-Path Networks

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Agenda

• Brief Intro
• Who/what is Cornelis Networks?
  • Doug will give much more detail in his talk
• What is OPX and why is it so great?
Who is this guy?

• OSU Graduate
  • A long long time ago, aka 2004
• Former Researcher here at the Ohio Supercomputer Center
  • OSC-Springfield
  • Spent many days working from this very room (BALE)
• Now: Engineer for Cornelis Networks
  • Kernel developer
  • Maintain drivers upstream
  • Main distro point of contact
  • Work closely with user lib (OPX) developers
Cornelis Networks

• From Startup -> QLogic (IB) -> Intel (OPA) -> Cornelis (OPX)
• Omni-Path Architecture (OPA) 100 Gbps Fabric
• Spun out of Intel 2+ years ago
  • Bring the customers and technology
  • Stand on our own now days
• Carry OPA flag forward and advance the technology
• Next Generation is 400Gbps (CN 5000) and beyond
  • See Doug Fuller’s talk
What is OPX?

- OPX is a libfabric (OFI) provider
- Eventual goal is replacing PSM2
  - Not a re-write or refactor of PSM2
  - Origins in BGQ (Blue Gene) provider
- Highly optimized
  - Support coming for GPU
  - MVPACH2 w/libfabric now available
- Does not require changes to hfi1 driver or Fabric Manager
- Really is a drop in replacement
MPI Direct to PSM2

- **Pros**
  - Library has direct access to PSM2
  - Fewer layers

- **Cons**
  - MPI Library has to support yet another API
  - PSM2 is not the path forward in OPA 400 and beyond
MPI to Libfabric - pre OPX

• Pros
  • Allows MPI layer to code to a single API stack

• Cons
  • Not optimal code path
  • PSM2 is not a great semantic match to libfabric
MPI to Libfabric with OPX

• Pros
  • Allows MPI layer to code to a single API
  • Allows MPI layer to have most efficient access to HW possible
  • Highest performance with a standard API
  • Same benefits as MPI->PSM2
  • Based on provider with proven performance

• Cons
  • New provider (under dev), takes time to upstream code
    • Upstream first is a key principle at Cornelis Networks
OPX Kernel and HW Access

• Driver IOCTL
  • Create user contexts (end points)
  • Discover details about HW contexts
  • Register TID recv buffers
  • Misc other tasks not involving data movement

• Memory Map
  • Access to PIO buffers
  • Access to eager array and header queue

• Driver writev()
  • Send in a list of SDMA requests
  • Data is NOT written just details on where to find it

• Direct HW Access
  • PIO buffers are mapped to HW registers
  • Driver is NOT involved in I/O to the PIO space

• Kernel HW Access
  • SDMA Engines are programmed based on writev()
Buffer Types Review

• Send
  • PIO – Programmed I/O (memory mapped) - Upstream Now
  • SDMA – DMA Engines on the hfi retrieve the user data - Upstream Soon

• Recv
  • Eager – Buffers that are filled as data comes in - Upstream Now
  • Expected – User buffers that are filled by the HW - Coming
Significant Performance Improvements
Intel Xeon Icelake Platform

- **Latency**: Up to 20% latency improvement
- **Message Rate**: Up to 2.4X messages/sec per core
- **Scalability**: Linear Scalability at double the throughput

Test Configuration:
2-socket Intel® 3rd Generation Xeon® Scalable (Icelake) Platinum 8358, Dual Rail OPA100, BIOS: Snoop Hold-off Response Timer=11, Energy Efficient Turbo=DISABLED, C-States=DISABLED
Rocky Linux 8.4 (Green Obsidian), Kernel 4.18.0-305.19.1.el8_4.x86_64, IntelMPI 2019.6, IMB 2019.6, IFS 10.11.1.1.1, OPX Build 225
Significant Performance Improvements
AMD EPYC Milan Platform

- **Latency**: Up to 25% latency improvement
- **Message Rate**: Up to 2.6X messages/sec per core
- **Scalability**: Linear Scalability at double the throughput

**Test Configuration:**
- 2-socket AMD EPYC (Milan) 7713, Dual Rail OPA100, xGMI Frequency Locked, xGMI Link Width Locked, P-State Disabled, PCIe Slot Frequency Locked
- CentOS Linux 8.3, IntelMPI 2019.6, IMB 2019.6, IFS 10.11.1.1.1, OPX Build 223
Why is OPX better?

• Other than the universal application support...
• Semantic match for libfabric
• Optimized for performance
  • Textbook SW Engineering not as important as pure performance
  • Goal is performance, not making it easy on developers
  • Instruction count, cache line footprint matter
  • Focuses on libfabric where as PSM2 is a flexible application itself
Example Improvement

- MPI_Recv()
  - Testing done with Intel SDE tool
    - Instruction count reduced by 38%
    - Cache lines for code reduced 60%
    - Cache line loads reduced 59%
    - New cache line access reduced 59%
Current Status

• Early MVAPICH2 numbers look very promising!
• OPX Code is upstream as of v1.15 of Libfabric.
  • Focuses on small message/latency first
• Next Optimizations
  • Large message improvements – upstream release imminent
  • DAOS optimizations
  • GPU support
  • Full GA
• Available on GitHub, Distro*, OPXS Software Suite
  • Checkout Libfabric ‘main’ branch
• Get involved
  • Happy to take patches via GitHub

*Depends when a distro gets latest libfabric
Thank You

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